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JOINT SIMULATION SYSTEM (JSIMS)

JOINT PROGRAM OFFICE (JPO)

Technical Requirements Document

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The Joint Simulation System Joint Project Office
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1. OVERVIEW

1.1 Document Overview

This technical requirements document (TRD) establishes the functional and system requirements for the Joint Simulation System (JSIMS). These requirements are to the level of specificity possible, given that both the Joint Conceptual Model of the Mission Space (JCMMS) and the JSIMS architecture are still under development. The description of JSIMS contained in the TRD includes capabilities provided by Development Agents (DAs) programs, as well as the JSIMS Integration and Development (I&D) program. The TRD also provides technical guidance for JSIMS.

Section 1 provides an overview of JSIMS, the JCMMS, and the JSIMS program's process for partitioning development responsibilities among the program participants. Section 2 lists references. Section 3 describes the system capabilities to be provided by JSIMS. Section 3 does not provide a detailed set of requirements, but rather a high-level set of functional and system requirements that will be used as the basis for the JSIMS System/Subsystem Specification (SSS). Section 4 provides Verification, Validation, and Accreditation (VV&A) requirements. Within Sections 3 and 4, each requirement is denoted with a "shall". Appendix A contains the acronym list.

1.2 JSIMS

JSIMS is a single, distributed, seamlessly integrated simulation environment. It includes a core infrastructure and mission space objects, both maintained in a common repository. These can be composed to create an interactive simulation capability to support Joint or Service training, rehearsal, or education objectives.

The JSIMS simulation environment will support the process of constructing, executing, and evaluating the results of a JSIMS exercise. The simulation environment will support the following phases that constitute an exercise:

- Pre-Exercise Phase (Planning and Preparation)
 - Scenario definition
 - Simulation environment composition
 - Simulation environment data initialization
 - Simulation environment configuration
- Exercise Execution Phase (Execution)
 - Simulation
 - Training Audience
 - Technical Control
 - Exercise Control
 - Role Player

- Post-Exercise Analysis/Review (Evaluation/Post-Exercise)
 - After Action Review

While these phases are described as distinct and separate, it is likely that overlap and repetition will occur among them.

The JSIMS architecture will be developed collaboratively with the JSIMS I&D contractor and the DAs and will use, as a point of departure, the JSIMS Domain-Specific Software Architecture (DSSA). The JSIMS system architecture will define the components of the simulation environment (including core capability (infrastructure and common services) and joint and service objects), their interfaces, a concept of system execution, and traceability between the components and the requirements.

JSIMS will be developed according to the emerging Department of Defense (DOD) Common Technical Framework for Modeling and Simulation (M&S), as described in the DOD M&S Master Plan, to include compliance with the High Level Architecture (HLA), use of the Conceptual Model of the Mission Space (CMMS), and use of data standards.

The JSIMS M&S Resource Repository (JMSRR) is a part of the JSIMS common utilities. It will contain the JSIMS core infrastructure and mission space objects and the simulations, models, and data that describe the JCMMS. The JMSRR will also contain exercise-specific scenarios for reuse. The descriptions will identify, among other information, the level of fidelity of the model and its VV&A history. The JMSRR will be part of the DOD M&S Resource Repository (MSRR) system. The MSRR is a structured framework that allows members of the DOD M&S community to link the resources they own into an organized collection of resources that can be easily located and accessed by M&S users.

JMSRR development will include the creation of a structure to permit the capture, storage, access and manipulation of models, data, metadata, code, scenarios, and any other relevant information necessary to satisfy training, rehearsal, and education requirements.

1.3 Joint Conceptual Model of the Mission Space (JCMMS)

The Joint mission space is the set of processes, functions, and tasks relevant to unified action executed by a Joint force in its area of operations and/or interest. The Joint mission space encompasses the following:

- All phases (planning, mobilization, deployment, employment, sustainment, and redeployment) of a unified action.
- War and military operations other than war (MOOTW) at the strategic, operational, and tactical levels.
- Friendly, enemy, and neutral forces, military and non-military, in the Joint area of operations/interest.

The JCMMS will be an implementation-independent, formal model of the real world Joint mission space. Its fidelity will be based on teaching, education, and rehearsal requirements. The JCMMS will use joint and service doctrine as a point of departure for developing products. JCMMS products will support object-oriented analysis and design and form the basis for verification, validation, and accreditation activities. It will provide authoritative descriptions of the Joint mission space for its subsequent development and representation in JSIMS. The JCMMS will encompass the component Services' tasks, component Services' interoperability tasks, and Joint tasks as described by CJCSM 3500.4, Universal Joint Task List. The JCMMS will identify and describe the entities of the Joint mission space, including their attributes, relationships, methods and processes, and interactions, under the following considerations:

- Physical Environment: natural and man-made physical conditions and effects including atmosphere/space, terrain, oceans, and biological components (other than military and civilian personnel) for all climates worldwide and dynamic changes due to natural interactions (e.g. mud, hurricanes, sunspot radiation) and man-induced interactions (e.g., bomb cratering, battlefield obscurants).
- Systems and Material: performance characteristics and utility of unmanned, individual, and crew-served equipment as influenced by human operators, doctrine and the physical environment; characteristics and capabilities for all classes of supply and material.
- Organization: permanent arrangements of systems into units designed to perform specified functions (e.g., aircraft carrier), temporary arrangements of units organized for a specific operational mission (e.g., carrier task force).
- Doctrine: fundamental procedures by which organizations (or elements) guide their actions in support of task execution and mission accomplishment, usually expressed through an organization's standard operating procedures, drills, and products of planning processes.
- Human Characteristics: human behavior, capabilities and limitations, learning, thinking, awareness, and judgment as influenced by the physical environment, task, doctrine, systems, materiel, and organization.

To ensure best use of resources and best possible downstream commonality, the JCMMS will be jointly developed by the JWARS and JSIMS programs, in coordination with the Executive Agents (EAs) and DAs. The JSIMS I&D contractor will collaborate with the EAs and DAs, as well as the JWARS program office, to ensure the timely development and availability of JCMMS products.

1.4 JSIMS Program Overview

JSIMS will be cooperatively developed with full support from Service development activities to maximize reuse of Service-developed components and to reduce redundant development efforts. JSIMS will be an evolutionary development with an initial operational capability (IOC) scheduled for 1999 and full operational capability (FOC) in 2003.

This cooperative development strategy is based on the use of EAs to provide authoritative representations for their domains. These representations may be requirements, models, software, or data. The representations of Air and Space, Land, and Maritime Warfare functionality will be provided via sponsorship by EAs. The US Army will be the EA for the land domain, the Air Force for the air and space domain, and the Navy for the maritime domain. The information domain is shared with the Defense Intelligence Agency (DIA), the EA for ISR (Information, Surveillance, and Reconnaissance), and DISA (Defense Information Systems Agency), the EA for C3 (Command, Control and Communications). The DoD M&S Executive Agents (MSEAs) for the physical environment will support the JSIMS Joint Program Office (JPO) to develop common and consistent representations for terrain, oceans, atmosphere and space.

The JPO and the EAs will provide management, user, and materiel development representatives to coordinate JSIMS development. The JPO, EAs, and DAs participate equally in the activities outlined in the Executive Agent Charter for JSIMS. These activities include mechanisms for:

- Developing the JCMMS.
- Delineating JSIMS core functionality (infrastructure and common services).
- Delineating EA functional area boundaries.
- Coordinating and resolving requirements, models, software, and data issues.

1.4.1 JSIMS JPO

The JSIMS JPO will be responsible for developing the core capability, Joint objects, and Joint interactions and for total system integration. The Joint objects and interactions will be developed by the JSIMS I&D contractor who will also be the systems integrator. The JPO may assign tasking for the development of selected core capability to the I&D contractor, or to other development agencies.

The I&D contractor will support the JSIMS JPO in establishing standards for development to ensure EA products are interoperable and in compliance with DoD guidelines.

1.4.2 EAs

The EAs support the implementation of JSIMS, within their functional domains, under the guidance of the JSIMS user representative, the Joint Warfighting Center, and the JSIMS JPO. The EAs provide management of their domains through policy and funding, in support of the JSIMS program, throughout the program life cycle.

EAs are responsible for providing resources for life cycle management and the development of requirements, models, software, and to meet that organization's requirements for JSIMS. Participants with other requirements (beyond JSIMS core functionality, Joint requirements, or EA requirements) will either provide necessary resources to the appropriate functional EA to develop and test products to meet their

requirements, or provide developed and tested products to the EA in accordance with the EA's standards.

1.4.3 DAs

The DAs will implement the assigned domain, as well as approved changes to the domain. They will provide agreed-upon deliverables (e.g., computer code, executables, and documentation) to the JSIMS program in accordance with JSIMS standards and will establish standards for software development that supplement the interoperability standards developed by the JSIMS JPO if required.

The DAs will provide technical support to the EAs and the JSIMS JPO in the development of JSIMS. The DAs will provide technical spokespersons for the domains and will be responsible for providing technical and operational assistance to the JSIMS JPO during system development, integration, and test.

2. REFERENCED DOCUMENTS

2.1 Government Documents

2.1.1 Specifications, Standards, and Handbooks

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

2.1.1.1 Specifications

DoD M&S High Level Architecture Interface Specification

DoD M&S High Level Architecture Security Architecture

DoD Joint Technical Architecture

2.1.1.2 Standards

Defense Information Infrastructure Common Operating Environment Integration and Runtime Specification (DII COE I&RS), Joint Interoperability and Engineering Organization - Defense Information Systems Agency

2.1.2 Other Government Documents, Drawings, and Publications

Modeling and Simulation (M&S) Master Plan (DoD 5000.59-P)

Executive Agent Charter for JSIMS

Universal Joint Task List (CJCSM 3500.4)

Modeling and Simulation Resource Repository (MSRR) Concept of Operations (CONOPS), Repositories Task Group (RTG) of the Data and Repositories Technology Working Group (DRTWG)

2.2 Non-Government Documents

3. REQUIREMENTS

3.1 Functional Requirements

The functional requirements for JSIMS are organized in this section according to the three phases of a JSIMS exercise: pre-exercise, exercise execution, and post-exercise analysis. JSIMS shall support simultaneous activity on multiple exercises where each of the exercises may be in a different phase. The functional requirements for the JMSRR are addressed separately in Section 3.1.4, as the JMSRR supports all phases of a JSIMS exercise.

3.1.1 Pre-Exercise Requirements

JSIMS shall provide automated tools with graphical user interfaces to perform the following pre-exercise functions:

- Rapidly define the exercise scenario.
- Compose the simulation and human-in-the-loop elements (role players and simulation audience) to support the scenario.
- Populate the simulation and human-in-the-loop elements with data.
- Configure the software, hardware, and networks that constitute the exercise system.
- Modify tactics

These tools shall provide the capability to review all of the above information and to modify it during exercise execution. These tools shall provide a capability for distributed and collaborative use across multiple geographic locations.

3.1.1.1 Scenario Definition

Scenario definition allows the exercise controller to establish the exercise objectives (e.g., training, evaluation of operational plans, or exercise and evaluation of headquarters' coordination procedures) and develop the scenario to meet its objectives.

JSIMS shall support development of military scenarios constructed from activities described in the JCMMS. Scenario definition tools shall support automated selection of scenario-specific information and JCMMS activities to include location, physical environmental conditions; time; friendly; opposing, civilian, and neutral forces; missions; rules of engagement; tasks; command and control relationships; training objectives; and simulation audience.

3.1.1.2 Simulation Environment Composition

The simulation environment includes everything (hardware, software, personnel, procedures, data, connectivities, etc.) required to conduct an exercise. Simulation composition allows the exercise controller to customize the simulation environment to meet a specific exercise objective and scenario.

JSIMS shall provide automated tools to support composition of the simulation environment, including human-in-the-loop elements, to support a scenario. These automated tools shall support all decisions and activities necessary to compose an exercise including:

- Allocation of forces among
 - Simulation audience
 - Role players
 - Semi-automated simulated forces
 - Automated simulated forces
- Simulation audience interfaces
- Types of simulated objects and interactions
- Level of resolution and fidelity of simulated objects
- Physical environment
- Level of abstraction of the synthetic environment
- Types of post-space and mid-exercise analysis
- Identification of data required for analysis and the plan for gathering that data during the exercise

JSIMS shall support access to, and the presentation of, existing scenario components. This information shall minimally include fidelity, level of detail, and specific content.

The tools shall support testing of simulation compositions to ensure that they meet training requirements.

3.1.1.3 Simulation Environment Data Initialization

Exercise controllers initialize the simulation environment with data, drawing on the JMSRR and validated, verified, and certified databases (including military, appropriate civilian, operational and exercise databases).

JSIMS shall provide automated tools for data initialization of the simulation and human-in-the-loop elements. This shall include population of all required object data to include the following:

- Force composition (Table of Organization & Equipment).
- Force behavior and doctrine.
- Force command and control relationships.
- Logistic support relationships.
- Equipment and personnel characteristics (weight, etc.).
- C4I data transportation media.
- Geographical location and tactical laydown of forces.
- Geographic features, both natural and man-made.

JSIMS shall provide a capability to automatically “run-up” data to a given point in time to include the following:

- Personnel, equipment, and communications media availability (to include equipment damage and reliability, personnel health and fatigue, and environment - weather, electromagnetic, chemical and nuclear effects).
- Filling of materiel, maintenance, and medical pipelines.
- Mobilization, deployment, and sustainment status.

JSIMS shall provide a capability to automatically populate the databases of the C4I systems used by the simulation audience, including maps, charts, weather reports, and ancillary environmental data.

JSIMS shall provide tools to support validation and, if necessary, correction of data (and recertification) to include data consistency checking, data dependencies checking, and overall scenario testing.

JSIMS shall provide a capability for automated data population from standard DoD databases, including those that represent environmental data (including terrain, ocean, atmosphere, weather, and space), force structure, targets, weapon, system, and platform parameters. JSIMS shall also support editing of the data to incorporate fictional (e.g., future) force and geo-specific, geo-typical, and historical physical environment data.

3.1.1.4 Simulation Environment Configuration

Technical controllers configure the simulation environment. JSIMS shall provide automated tools to configure the software, hardware, and networks that constitute the simulation environment. These tools shall support the following:

- Network design (the ability to specify the required characteristics of wide area and local area networks, and ensure that proposed components are capable of supporting the requirements).
- System parameter selection.
- Location, distribution and configuration of computers and workstations, whether locally clustered or geographically distributed.
- Allocation of software to computers based on hardware location and load balancing across hardware.
- System checkout of all software and network connectivity (after installing all exercise components, assurance that the components work together to support the requirements of the exercise).

3.1.2 Exercise Execution Requirements

Exercise execution entails simultaneous execution of the simulation, simulation audience supporting software, technical control tools, exercise control tools, role player support tools, and after action review tools.

3.1.2.1 Simulation Scope

JSIMS shall provide a simulation capability that allows the simulation audience to perceive a representation of the real world for all JCMMS activities relevant to the exercise scenario and objectives. Specific functional characteristics of the simulation are described below.

3.1.2.1.1 Mission Space

JSIMS shall provide the facility to simulate the entire mission space, and any subset of that mission space, described in the JCMMS, including the following:

- All mission phases, including planning, mobilization, deployment, employment, sustainment, and redeployment.
- All missions, including all levels of war and MOOTW (insurgency, counter-insurgency, anti-terrorism, peacekeeping, counter-drug, non-essential personnel evacuation operations, and shows of force).
- All levels of war, including national/strategic, theater, operational, and tactical levels.
- All forces, including friendly, enemy, and neutral forces, military and non-military.
- All domains of the physical environment, both natural and man-made.

For a particular exercise, JSIMS shall permit limiting simulation to only those aspects dictated by the requirements of the exercise.

3.1.2.1.2 Simulated Forces and Activity

JSIMS shall be capable of simulating all forces and activities described by the JCMMS. The capabilities and limitations of the forces include the following:

- JSIMS shall provide the capability to simulate multiple alliances and/or coalitions in an exercise.
- Coalitions of forces on all sides shall be allowed to vary throughout the conduct of the exercise. JSIMS shall provide the capability to allow coalition members to support one another with forces, facilities, supplies and intelligence products.
- JSIMS shall provide the capability to represent the activities of national theater, and tactical intelligence, surveillance, and reconnaissance (ISR) assets including tasking, collection, reporting, and use. Within tasking activities, JSIMS shall provide the capability to represent the competition for national assets that tactical level operators experience. Within collection, JSIMS shall provide the capability to represent current and future Defense Airborne Reconnaissance Office missions at no higher than the appropriate TS/SCI or TS/SI/TK classification. Within reporting, at IOC JSIMS shall provide the capability to report intelligence via all current intelligence message formats.
- JSIMS shall provide the capability to represent the national infrastructure(s) within which simulated Joint forces must operate. In particular, JSIMS shall represent the use or disruption of national government, political, and religious organizations, communications networks and facilities, transportation infrastructure, industrial and fuel production facilities, and electrical power grids.

- JSIMS shall provide the capability to represent theater to tactical infrastructures within which simulated Joint forces must operate. In particular, JSIMS shall represent the use or disruption of communications networks and facilities (e.g., radios, land lines), transportation infrastructure (e.g., roads, rivers, bridges, rail lines/heads, fuel pipelines, airports, and air corridors and logistics networks and supplies distribution).

3.1.2.1.3 Behavior

JSIMS shall properly represent the behavior of forces and their commanders to a level commensurate with the purpose of the exercise. Where appropriate, this behavior shall include (1) the ability for C2 elements to select courses of actions or issue orders based upon faulty judgment, inadequate knowledge, or misinterpretation of the situation and (2) the degradation of unit and human effectiveness due to conditions experienced during military operations. The latter shall include factors such as combat experience, level of training, fatigue, social/religious/moral/environmental conditions (e.g., climate, weather, presence of nuclear-biological-chemical (NBC) contaminants), nutrition, sleep deprivation, and political influences.

3.1.2.1.4 Simulated Commanders

JSIMS shall represent all of the command and control (C2) elements and processes required to effectively simulate the mission space. JSIMS shall represent the varying levels of C2 fidelity and detail appropriate to match the current levels in a JSIMS supported exercise.

At FOC, JSIMS shall include enough simulation of the C2 elements and processes for each Military Service so that an individual Military Service could use JSIMS with minimal presence of other Service representatives as role players and a Joint exercise could be conducted without direct participation of Service representatives as role players.

JSIMS representations of C2 elements and processes shall base their decisions on their perceptions of the mission space situation. This shall include perceptions of the current and expected state of the natural environment, and perceptions derived from communications, intelligence, surveillance, and other collection assets available to them. JSIMS simulations of C2 elements shall not use ground truth simulation data to make perfectly informed decisions.

These simulations of C2 elements and processes shall have physical presence in the simulated mission space and shall be subject to the effects of the natural environment, as well as to surveillance, attrition, and information warfare by friendly, neutral, and opposing forces.

3.1.2.1.5 Synthetic Environment

JSIMS shall provide a coherent representation of the physical environment, whether natural or man-made. This representation shall be perceived consistently by all participants, even when operating in a distributed mode at dispersed geographic sites.

JSIMS shall utilize authoritative representations of the physical environment, systems, and associated behaviors and interactions. JSIMS synthetic environment representations JSIMS shall be responsive to force activities and the conditions and standards described in the Universal Joint

Task List (UJTL) to the extent appropriate to exercise requirements. These include, but are not limited to, the following:

- Battlefield obscurants, including smoke, dust, explosive debris.
- Vehicle effects on:
 - Terrain, including combat engineering works, minefields, tracks, and surface cover destruction (e.g., tree felling).
 - Atmosphere, including visual and acoustic effects (e.g., contrails, vortices).
 - Ocean, including wakes and acoustic and thermal emissions.
- Weapons effects (e.g., artillery, minefields, shaped charges) on terrain and structures, atmosphere (e.g., dust) and ocean (e.g., blue out, explosive mine clearance).

Simulated force activities in JSIMS shall be responsive to synthetic environmental conditions to the extent appropriate to exercise requirements. These include, but are not limited to, the following:

- Models for motion dynamics affected by changes to the physical environment, e.g., surface strength, temperature, pressure, humidity, and wind.
- Models for sensors affected by changes to the physical environment, e.g., atmospheric haze and dust, effects of cloud cover, surface temperatures, and ambient noise.

Synthetic environmental representations shall be responsive to interactions with other Synthetic environmental representations. Those interactions (especially when occurring across the terrain, atmosphere, space, and ocean domains) shall result in consistent, valid environmental simulation behaviors. Examples include mud caused by water on the terrain, beach erosion caused by waves, and sea state influenced by winds.

To create a consistent mission space representation, measurable descriptions of the synthetic environment, its components, and activities shall be developed and maintained as the standard for all JSIMS developers and users.

JSIMS shall use standardized representations of the physical environment where feasible to facilitate interoperability with other M&S and C4I systems and reduce data development costs.

3.1.2.1.6 Effect on C4I System

JSIMS shall interface to C4I systems via the HLA and, where feasible, shall use the Modular Reconfigurable C4I Interface (MRCI). Any interfaces between JSIMS and C4I systems shall minimize changes to the C4I systems.

The JSIMS interfaces to C4I equipment shall not degrade the performance of the C4I equipment. JSIMS shall provide information to real-world systems in formats expected by those systems through the use of a DOD-developed common interface to C4I systems. JSIMS shall, in conjunction with C4I system design, provide safeguards to avoid compromising real world C4I databases or confusing exercise events with real-world data or events.

3.1.2.1.7 Network and Communications Systems Representation

JSIMS shall simulate the real-world effects on network and communications systems and shall subject communications using those systems to propagation and loading effects and bandwidth and latency limitations.

At IOC, JSIMS shall simulate these effects on communication between the simulation audience and simulated entities, and among simulated entities. At FOC, JSIMS shall additionally simulate these effects on communication among the simulation audience, role players, and live entities.

3.1.2.1.8 Supply

(TBD)

3.1.2.2 Simulation Attributes

3.1.2.2.1 Resolution

JSIMS shall simulate battlefield entities and activities with sufficient detail and resolution to satisfy all user requirements for the exercise. This dictates that JSIMS simulate forces at multiple levels of resolution.

JSIMS shall ensure the interactions among force representations and between force representations and the synthetic environment are valid.

For IOC, JSIMS shall support a limited range of force representations in a given exercise. For FOC, JSIMS shall support wide ranges of force representations in the same exercise.

Aggregation of battlefield entities (and associated physical environment representations) into larger groupings (i.e., variable resolution) shall be supported.

3.1.2.2.2 Control

All manipulation of simulated JSIMS battlefield entities shall occur through operator facilities described in the Simulation Audience, Exercise Control, or Role Player sections.

JSIMS shall allow the software simulations of C2 elements or processes within the simulated battlespace (friendly, neutral, or opposing force) to be interchangeable with a human simulation audience participant or role player.

- The exercise controller may choose to use human participants in decision-making roles that can then be executed automatically in the simulation system.
- A role player may be used in a decision-making role where he or she communicates with subordinate simulated entities at IOC and in any combination of superior, subordinate, or adjacent simulated entities at FOC.

JSIMS shall provide the capability to switch a specific decision-making entity from its computer-generated representation to a human simulation audience for role playing participant or vice versa, during the course of an exercise without stopping the exercise.

3.1.2.2.3 Performance

JSIMS shall be a time-managed simulation with variable time resolution as required by the scenario. JSIMS shall support time-management services provided by the HLA.

JSIMS shall be capable of simulating a major regional conflict (MRC) while maintaining an average clock speed (averaged over one hour of wall clock time) of 1:1 with wall clock for scenarios that execute in real time. Clock speed shall not exceed 1:1.4 nor fall below 0.8:1 for these scenarios.

For missions that execute faster than real time (e.g., mobilization), JSIMS shall be capable of simulating the scenario at game ratios between 1:10 (slow time) and 100:1 (fast time).

JSIMS shall provide all communications and coordination to all JSIMS elements (AAR, exercise control, technical control, simulation audience) in such a manner that any element's picture of the simulation is no more than 30 seconds behind that of the simulation.

Facilities shall be provided to save the state of all components of JSIMS in less than five minutes. In the event of a software failure, facilities shall be provided to permit resumption of the exercise such that the simulation time and state are the same as those at the point of failure. Resumption shall be accomplished within one hour after problem diagnosis.

3.1.2.3 Simulation Audience

The JSIMS simulation audience includes CINC, Joint Task Force, component, and service commanders and battle staffs, and service education and training participants. JSIMS shall provide a simulation environment that allows for actual operational conditions for participating battlestaffs.

The simulation audience participates in the simulation environment by interacting with other commanders or forces. This interaction shall occur through the C4I systems used during normal operations. The simulation audience shall only have access to perceived data. At IOC, the communication shall be with other members of the simulation audience, with role players, or with simulated entities. At FOC, the communication shall additionally include live and virtual simulators.

3.1.2.3.1 Distribution

JSIMS shall be capable of supporting a globally dispersed simulation audience (to include members aboard ships at sea and individual combatants in the field). It shall maintain a consistent presentation, in time and content, of perceived simulation data at all simulation audience locations.

3.1.2.3.2 C4I System Use

JSIMS shall support the use by the simulation audience of real-world (operational) C4I systems. When appropriate, JSIMS shall provide output via real world tactical communications networks. These systems range from complex automated information systems such as the Global Command and Control System (GCCS), to systems that receive RADAR tracks, to traditional mechanisms

such as telephone, secure telephone, radio, teletype (including paper maps, charts, and reports), to emerging communications media such as video-teleconference, electronic mail, and the World-Wide Web (WWW), and to training and exercise support systems such as the Synthetic Image Generation System (SIGS).

For interactions between the simulation audience and simulated entities, the operational C4I systems shall be used. At IOC, the C4I systems that pass data in standard message formats (content and trigger conditions) over data links shall be supported. At FOC, non-standard data shall be supported, such as voice and video communications.

The operational C4I systems shall also be used for interactions between the simulation audience and other members of the simulation audience and role players. At FOC all C4I systems and data transportation media shall be supported.

3.1.2.4 Technical Control

The technical control staff is responsible for technical monitoring and control of the software, computers, and networks that comprise the exercise. JSIMS shall provide tools to support the activities of the technical control staff. These tools shall provide centralized control of JSIMS and permit manipulation of the exercise without disrupting the execution of the simulation. Where possible, COTS tools shall be used or adapted to meet JSIMS needs. The capabilities required of these tools are described in the following subparagraphs.

3.1.2.4.1 Network Control

JSIMS shall provide the ability to monitor the status of the networks used during an exercise. Information available for monitoring shall include general network traffic load, JSIMS-specific traffic load, and specific link information. JSIMS shall provide a technical controller with the means to reconfigure the JSIMS exercise network without disrupting the exercise.

3.1.2.4.2 Computer Control

JSIMS shall provide the ability to monitor the status of the computers used in an exercise. This status shall include both general workload and workload for each resident application. It shall include processor loading, memory demands, and input-output load.

Without interrupting the conduct of the exercise, JSIMS shall provide the technical controller with the means to add new computers to the exercise and to initiate software in the computers; to reassign software from running in one computer to running in another; and to remove computers from the exercise.

JSIMS shall provide the means to add, delete, and modify workstations and C4I systems supporting the simulation audience and role players.

JSIMS shall provide a means to monitor the computer system status and alert operators of any changes that may effect simulation performance.

3.1.2.4.3 Software Control

JSIMS shall provide a means for technical controllers to control the execution of the simulation from a single location. These controls shall include the following:

- Initiate the applications
- Perform system checkout
- Start execution
- Pause execution
- Change simulation rate (alter the ratio of simulation time to clock time)
- Save the state of all software components in the exercise configuration (snapshot)
- Restart the execution from a previously saved state
- Shut down the execution of the exercise

3.1.2.5 Exercise Control

JSIMS shall provide tools to support the activities of the JSIMS exercise control staff. This staff is responsible for the conduct of the exercise-to modify simulation events and activities in order to ensure that the exercise objectives are met. The tools shall be available to authorized users anywhere in the exercise configuration.

JSIMS shall provide tools to view and modify simulation data. These tools shall have access to and control over all simulation data (ground truth and truth as perceived by role players and simulation audience). Specific capabilities of these tools shall include the following:

- A viewer that shows the battlefield geography and forces with the ability to pan, zoom, and, at FOC, assume the viewpoint and battlefield knowledge of a particular simulation entity ("stealth view") and provides both plan view and immersive, perspective presentations of the battlefield.
- A query and change capability with the ability to observe the status of any battlefield entity or synthetic environment element and modify that status. This modification ability includes individual state variables (such as aircraft altitude) and broad characteristics (such as reconstituting a "dead" unit to 90% capable, moving a unit from one area to another; or realigning the allegiance of a unit).
- A monitor capability for observing the current values of attributes of battlefield entities and the synthetic environment.
- The ability to create and destroy battlefield entities during the conduct of an exercise.
- The ability to change the resolution of simulated forces.
- The ability to change data collected for after action analysis.
- The ability to designate which role players have access to ground truth data and which role players are limited to perceived data.

- The ability to add or delete simulation audience participants and role players, and to substitute simulated commanders for either (and vice versa) at any time during exercise execution.

3.1.2.6 Role Player

JSIMS shall provide tools to support the activities of the JSIMS role players. Role players act as interfaces between the operational world and the simulated world. Examples of the roles that they may play include the following:

- **Surrogate:** The role player interfaces with the simulation audience. The role player could be a superior to the simulation audience, providing orders and accepting information; he could be a peer, coordinating activities; or he could be a subordinate, accepting orders and providing information.
- **Ally/Coalition Commander:** The role player commands all or a portion of forces acting in concert with forces under the command of the simulation audience. He coordinates his activities with other ally and/or coalition commanders, with simulation audience surrogates, and with the simulation audience.
- **Enemy Commander:** The role player commands all or a portion of forces acting against the forces under the command of the simulation audience.
- **Other Service Commander:** The role player commands all of the simulated forces belonging to a Military Service. JSIMS shall provide sufficient supporting tools so that a representative from another Service could perform in this role with minimal understanding of the operations of the Services being simulated.

Information that is available to the role player shall be either perceived data and/or ground truth, as specified by the exercise controller. Tools that JSIMS shall make available to role players will include the following:

- A stealth viewer, as described in 3.1.2.4.
- A monitor capability for observing the reported or true values of attributes of battlefield entities (friendly and detected hostile forces) and the synthetic environment.
- A query capability with the ability to observe the reported or true status of any battlefield entity or the synthetic environment.
- A capability to construct and generate orders to subordinates and reports to superiors and peers. These orders and reports shall include the characteristics of normal military orders and reports and be restricted to the types of direction and reporting that a commander could exert over his forces and peers. However, the tools that support construction and generation of the orders and reports shall include mechanisms to reduce workload and permit a broader span of control by the role player.

3.1.2.7 After Action Review

During the execution of an exercise, JSIMS shall provide for archiving of relevant exercise data and for on-line analysis. This data shall include information relating to the following:

- The execution of the military scenario (to include opposing forces).

- The baseline synthetic environment used during the execution of the military scenario.
- The information exchange between the simulation audience, the role players, and simulated entities.
- The performance of the system (workload of computers, networks, etc.).
- Subjective observations made by observers collocated with the simulation audience.

JSIMS shall archive data to an on-line database during the conduct of the exercise. The selection, frequency, and format of the data shall be as determined during the pre-execution phase of the exercise. An exercise controller shall be able to alter these criteria during the exercise.

JSIMS shall permit analysis of archived data while the exercise is underway. The analysis requirements include the following:

- The exercise controller shall be able to select the data for analysis using a variety of selection criteria (category, force type, force echelon, time interval, time period, for example).
- The exercise controller shall be able to select from a variety of data reduction tools.
- The exercise controller shall be able to select from a variety of presentation tools. In addition to normal graphing and charting tools a geographic mapping tool shall be available with the ability to overlay time-stepped tracks, snap shot positions, and abstract relationships.
- JSIMS shall provide the ability to replay portions of the exercise at controllable rates of speed.
- The exercise controller shall be able to select from several display techniques including on-screen graphics, projections, and printed output (color and monochrome), as well as perspective, immersive displays. Facilities shall be provided to permit simultaneous review at dispersed geographic locations.
- Standard queries and output formats shall be provided for the exercise controller.
- Customized queries and output formats shall be provided for the exercise controller.
- The analysis shall map outcomes to the UJTL and applicable doctrine.

The maximum possible use shall be made of COTS/GOTS tools for database management systems (DBMS), data reduction, and data presentation. The performance of these tools shall be such that a three-person team of exercise controllers can collate a daily status report for presentation to the exercise sponsor in less than two hours, or a team of six analysts shall be able to present a "hot wash" type briefing to the simulation audience from previously extracted and archived data within three hours of the training event conclusion.

3.1.3 Post-Exercise Requirements

After completion of an exercise, JSIMS shall provide for the use of archived simulation data for on-line review and analysis. This process shall include the same capabilities presented in Section 3.1.2.7, After Action Review, with one addition: The operator shall have the facility to prepare "take-away" packages for exercise participants, particularly for the simulation audience. These packages shall provide for the orderly presentation of analyzed data and for the production of tables of contents and indices to the presentation material.

3.1.4 JMSRR

The JMSRR shall be a repository for information to include, but not limited to, the following:

- The JCMMS.
- Exercise scenarios definitions, synthetic environment compositions, and data-populated synthetic environments for reuse.
- Snapshots of exercise state for restart or replay.
- Post-exercise analysis results.

The JMSRR shall provide tools for the capture, storage, access, and manipulation of these kinds of information as well as the preservation of the integrity of the information stored in the JMSRR.

3.2 System Requirements

To effectively support current and future functional requirements with substantial improvements over legacy simulations, JSIMS will be developed using modern computer technologies and software engineering principles.

3.2.1 Computer Resource Requirements

JSIMS hardware will normally be located in, and operated from existing Simulation, Training, and Command and Control Centers. JSIMS shall adhere to industry standards for power consumption, temperature and humidity conditions, and reduction of electromagnetic interference.

3.2.2 Domain Specific Architecture

The JSIMS architecture shall be consistent with the JSIMS DSSA. The life cycle support to JSIMS shall include refining and evolving the DSSA.

3.2.3 Software Quality Factors

JSIMS shall be developed using modern software engineering practices that contribute to good software quality. This section introduces requirements for the following software quality factors:

- Interoperability (the ability of two or more systems to exchange information and to mutually use the information that has been exchanged).

- Expandability (the extent to which the software can be improved for performance or other software attributes).
- Reliability (the ability of a program to perform a required function under stated conditions for a stated period of time).
- Correctness (the extent to which software is free from design and coding defects, meets its specified requirements, and meets user expectations).
- Portability (the ease with which software can be transferred from one computer system or environment to another).
- Usability (the initial effort to learn, and the recurring effort to use, the functionality of the software).
- Reusability (the extent to which a module can be used in multiple applications).
- Maintainability (the ease with which the software product can be modified to overcome existing faults).

3.2.3.1 Interoperability

The following features of the JSIMS architecture are necessary to support interoperability:

- The architecture itself shall be composed of modular components. The design shall foster data encapsulation and well-defined interfaces.
- Core infrastructure objects shall interact with each other and with simulation components through a well-defined Application Program Interface (API).
- The architecture shall treat all simulation components as “black boxes,” interacting only through the API.
- The services provided by the architecture shall be organized into layers or levels, ranging from “kernel” to higher-level services. Kernel services shall be restricted to primitive operations such as object-object distributed communication, event scheduling and timing, data access, and message logging, all of which are basic to a simulation. Well-defined interfaces shall be required between each layer to allow for replacement.
- JSIMS shall provide data distribution, time management and other coordination services between simulations, selected common services, and with C4I systems through the DoD-common HLA Runtime Infrastructure (RTI).
- A well-defined, generic API shall be defined for tools to execute, as stand-alone programs, within the architecture framework.
- The architecture shall support distribution of software processes across multiple computers and geographic locations.

To facilitate development of data interchange and transformation mechanisms and their configuration into simulations, the JSIMS architecture shall provide the following features:

- A common object format (including the class structures, component relationships, associations, object attributes, object interactions, and a data dictionary) for intra-simulation interoperability using a robust distributed object message/interaction protocol.

- Data standardization that is consistent with DoD guidelines such as those provided by the DoD M&S Master Plan.
- "Mix and match" communications services which can be configured to handle the required interfaces to external simulations, ranging from satellite link to TCP/IP to serial data link.
- A standard API for communications services so that new communications protocols may be added readily to JSIMS.
- Isolation of a physical system translation layer for each external system instance to afford maximum reuse between the API and the system-specific layer.

3.2.3.2 Expandability

JSIMS shall be flexible so that changes to the external system interfaces may be incorporated to provide interoperability with releases and/or upgrades of identified and new external systems. The JSIMS architecture shall also be adaptable to support rapid introduction and/or insertions of advanced technology within the system. The architecture shall facilitate the evolution to broader applications and the customization to site-specific needs. To achieve this level of expandability, the JSIMS software shall be developed to support the following open system characteristics:

- Provide a "core" of support software and a suite of software tools and standards compliant with HLA.
- Make use of modular design and component technology which supports the integration of new hardware and software modules and substitution of compatible hardware to embrace the pace of new technology.
- Provide sufficient flexibility and performance to support changes and extensions to the models.
- Use well-defined APIs between the models and the common services.
- Minimize the interdependencies between software components so that the effect of change is localized.

The JSIMS design shall have the ability to readily accommodate modifications and additions to satisfy the evolving requirements in both the JSIMS architecture and the JSIMS simulations. The JSIMS architecture and design shall have the flexibility and extensibility to accommodate changes to the architectural components. The JSIMS architecture shall be defined in anticipation of the evolution and likely adoption of the DoD HLA and Joint Technical Architecture (JTA) by IOC:

JSIMS will be a cooperative development effort with the JSIMS I&D contractor integrating system components developed by DA programs.

3.2.3.3 Reliability

JSIMS shall support exercises with durations of from 1 to 30 days and shall be capable of operating 24 hours per day with a system availability of at least 95%. Availability is defined, in this instance, as all components of the system being operated at technical control designated

speeds, including the pausing or shutting down of selected components, with the system continuing to process data normally. The system shall be capable of restarting no more than one hour after correction of a full system failure.

The effect of failure of individual components of JSIMS shall be minimized. An exercise shall have the capability to proceed with failed components, although with degraded capability, and that failed component shall recover fully with minimal effect on the rest of the system.

Technical control speeds and other measures of performance shall be defined for each major component (hardware, software, communication, and network) of JSIMS.

3.2.3.4 Correctness

Data sets shall be generated in an automated manner from authoritative data sources.

3.2.3.5 Portability

JSIMS shall be portable and have the ability to execute across heterogeneous LANs and/or network suites. It shall be capable of being transferred between homogenous and heterogeneous platforms with minimal or no modifications.

Methods shall be employed to ease portability of the simulations to a new environment containing hardware and software services that may differ from the original implementation.

All software languages used to develop JSIMS shall be supportable across heterogeneous platforms. Proprietary software languages shall not be used. Languages for which there is an industry standard shall be used wherever technically feasible and cost effective. All commercial software shall have interfaces based upon industry standards wherever possible.

3.2.3.6 Usability

The design of user displays shall be based upon guidelines compatible with industry standards. The JSIMS user display designs shall provide ease of use and convenience to users. On-line help shall be available.

A software development support environment shall be employed that includes automated tools and or manual processes that enhance productivity and allow for the ease of developing or changing the application software. These tools and processes shall support the design, build, test, and operational phases of the system implementation. JSIMS shall provide utilities and tools to support error handling, system monitoring and system debugging.

3.2.3.7 Reusability

JSIMS shall provide common services (ranging from low-level system utilities to higher-level applications such as database management) constituted of tools and reusable shared software components for use by objects and models. Common services will be constituted of components which meet Government and industry standards promoting open architecture in a multiple vendor heterogeneous environment. These services shall include components such as: network services,

graphics, security, operating systems, documentation, instrumentation, system management, distributed computing environment, knowledge servers, and other services.

Software components shall be designed such that model parameter, rules, and network configuration data are not hard-coded into the software, and can be changed without disruption to an exercise.

3.2.3.8 Maintainability

Quality, non-proprietary software documentation and source code that facilitates software maintenance shall be developed and delivered.

3.2.4 Security and Privacy

JSIMS core components shall establish and maintain effective security measures to ensure protection of the information they process and store.

Safeguards shall be provided to ensure that all information and resources are accessed only by authorized individuals possessing the appropriate security clearance and need-to-know, are used only for their intended purposes, retain their content integrity, and are marked properly. The mix of safeguards selected shall be compliant with the HLA Security Architecture and shall achieve the requisite level of security or protection consistent with the System High mode of operation. Portions of the simulation shall operate at System High (TS/SI/TK) platform, and shall interface to systems or networks operating at all security levels to include the Secret or Secret/Releasable levels. Those portions shall be designed in such a way as to minimize overall classification in order to facilitate operations in the JSIMS environment.

JSIMS shall protect classified data through concepts integrated into system hardware and software as part of the architecture for storing, retrieving, and passing data between subsystems. External protection devices may be used.

JSIMS shall protect against information systems security (INFOSEC) threats as defined by the designated approving authority at each anticipated deployment site.

The system shall include the ability to scan media for known viruses and to remove any detected viruses via technical control.

3.2.5 Integrated Logistics Support

JSIMS shall accommodate a to-be-defined integrated logistics support concept to meet the JSIMS reliability requirements as previously stated.

3.2.6 Personnel and Training

3.2.6.1 Personnel

JSIMS shall allow fielding within reduced manpower constraints. JSIMS shall reduce the overhead associated with current simulation-supported training, through reduced requirements

for technical controllers, exercise controllers, and role players. At IOC, the number of overall support personnel overhead shall be reduced by at least two thirds of what was required for a Joint Training Confederation-supported JTF level exercise in 1995.

JSIMS shall provide the capability to incrementally automate many of the manpower intensive control functions typical of existing simulations throughout the exercise time frame.

JSIMS shall reduce the number of technical controllers, by providing automated support for simulation environment configuration and a capability to operate the components of JSIMS from a central simulation control location.

JSIMS shall reduce the number of exercise controllers by providing tools for pre-exercise scenario generation, exercise execution time exercise control, and post-exercise analysis.

JSIMS shall reduce the number of role players by substituting simulated commanders for role players.

JSIMS shall reduce the amount of first-time training and refresher training required through the use of common user interfaces, enhanced user interfaces, point-and-click features, and on-line help.

3.2.6.2 Training

JSIMS shall minimize training requirements and the life-cycle cost of training. Training shall be required for technical controllers, exercise control staff, and role players.

Training shall include computer-based tutorials and hands-on rehearsal sessions, and shall familiarize the users with the availability of on-line help, checklists, and glossaries.

JSIMS operation shall be user friendly so that learning to operate the system is simplified. No more than 24 hours of training shall be required to train new technical and exercise controllers and role players.

Training for JSIMS technical controllers shall cover the life cycle of a JSIMS exercise. The training shall include hardware and software operation, installation procedures, and checklists. The training shall also include software execution and checklists for both normal and abnormal operations. Training and checklists shall include indicators of hardware, software, and network communication problems or limiting factors.

3.2.7 Interface Requirements

3.2.7.1 HLA

JSIMS shall be compliant with the HLA to support interoperability among the following:

- JSIMS simulation components representing domains across the JSIMS mission space (as required by simulation design).
- JSIMS simulation components and JSIMS common services to include technical and exercise control, AAR, and others as required by common services design.

- JSIMS simulation components and live participants via C4I systems.

3.2.7.2 C4I Systems

Where feasible, JSIMS shall use the MRCI to interface with C4I systems. All interfaces to C4I systems shall be compatible with the DII COE.

3.2.7.3 Other Simulations

HLA compliance will also provide a framework for interoperability between JSIMS simulation components and other virtual and constructive simulations. JSIMS shall meet Government-established interoperability standards in order to exchange operationally valid scenarios with the Joint Warfare System (JWARS) or similar emerging analytical systems.

3.2.7.4 MSRR

As a node on the MSRR, JSIMS can both link to resources and provide access to JSIMS resources with other DoD M&S programs. As part of the MSRR, the JMSRR shall comply with the architecture standards of the MSRR's distributed client-server network.

3.2.8 Precedence and Criticality of Requirements

This document describes all the currently known hardware, communications, software, and external interface requirements that apply to JSIMS integration and development.

JSIMS will be an evolutionary development which will incorporate user feedback from one version to another, and as such, its requirements will continue to evolve for the foreseeable future. In addition, these requirements will evolve as the operational concepts for unified action and system interoperability continue to mature.

The requirements cited in this version of the document are based on the information available at the time this TRD was prepared. The specific content of each JSIMS hardware and software version will be defined through integrated product team (to include the JSIMS users) version planning process that precedes the associated development, integration, and qualification effort.

Technical and programmatic assumptions are stated in the sections of this document to which they apply.

The requirements stated in this document shall supersede JSIMS requirements stated in preceding documents. The requirements listed in Sections 3 and 4, their related requirements and any subsidiary requirements derived from them, shall have equal precedence relative to one another, and shall have higher precedence than any other system requirement. All other system requirements shall have equal precedence relative to one another.

4. VERIFICATION

The activities and processes used to assess the accuracy and credibility of a simulation are collectively referred to as VV&A. *Verification* is the process of determining that a model or simulation implementation accurately represents the developer's conceptual description and specification. *Validation* is the process of determining the extent to which a model or simulation is an accurate representation of the real world from the perspective of the intended use(s) of the model or simulation. *Accreditation* is the official certification that a model or simulation is acceptable for use for a specific purpose.

The I&D contractor shall support VV&A processes and procedures that:

- Determine that implementations of JSIMS models and simulations accurately represent the I&D contractor's conceptual description and specification.
- Evaluate the extent to which JSIMS models and simulations have been developed using sound and established software engineering principles.
- Ensure that accurate and realistic data exists in each of the pieces contributed to JSIMS from the designated EAs.

Appendix A Acronym List

AAR	After Action Review
API	Application Program Interface
C ²	Command and Control
C ⁴ I	Command, Control, Communications, Computers and Intelligence
CASE	computer-aided software engineering
CJCSM	Chairman Joint Chiefs of Staff Manual
CMMS	Conceptual Model of the Mission Space
COE	Common Operating Environment
COTS	Commercial off-the-shelf
DA	Development Agent
DBMS	Database Management System
DII	Defense Information Infrastructure
DoD	Department of Defense
DoDISS	Department of Defense Index of Specifications and Standards
DSSA	Domain Specific Software Architecture
EA	Executive Agent
FGDC	Federal Geographic Data Committee
FOC	Final Operational Capability
GCCS	Global Command and Control System
GOTS	Government-off-the-Shelf
HLA	High Level Architecture
I&D	Integration and Development
INFOSEC	Information Systems Security
IOC	Initial Operational Capability
ISR	intelligence, surveillance, and reconnaissance
JCMMS	Joint Mission Space Model
JPO	Joint Program Office
JMSRR	JSIMS Resource Repository
JSIMS	Joint Simulation System
JTA	Joint Technical Architecture
JTF	Joint Task Force
JWARS	Joint Warfare System
M&S	Modeling and Simulation

MSEA	DoD M&S Executive Agent
MOOTW	Military Operations Other Than War
MRC	Major Regional Conflict
MSRR	Modeling and Simulation Resource Repository
NBC	Nuclear-Biological-Chemical
OMG	Object Management Group
RTI	Runtime Infrastructure
SCI	Special Compartmented Information
SIGS	Synthetic Image Generation System
SSS	System/Segment Specification
TRD	Technical Requirements Document
UJTL	Universal Joint Task List
US	United States
USD(A&T)	Under Secretary of Defense (Acquisition and Technology)
VV&A	Verification, Validation, and Accreditation
WWW	World-Wide Web